SECTION 1. INTRODUCTION

1. THE LEDA TRAITBASE PROJECT

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To date there has been considerable effort to build up databases to synthesise information on plant traits. The knowledge of plant traits is currently growing fast, but remains scattered over many sources, i.e. in different journals, large monographs, and herbarium records. Also the sources are presented in various different languages and the data are distributed across many European countries, collected and stored in different ways and mutually not integrated. This severely impedes the functional analysis of plant species-environment relations and the prediction of plant biodiversity after changes in land use in Europe or regions within Europe. Thus the key ecological data for the European flora are too few and too scattered to be effective and without a standardised database of traits for the European flora, planning, nature conservation and restoration instruments will not operate effectively and European biodiversity will continue to decline. Neither the problem nor the flora respect national borders and therefore a response beyond the national level was required.

The LEDA Traitbase project started in 2002 in the fifth framework programme (FP5) of the EC within the Energy, Environment and Sustainable Development programme (EESD). The project aims to provide an open Europe-wide database of plant traits relevant to the conservation and sustainable use of biodiversity in changing European landscapes. To start with the LEDA Traitbase deals with the flora of Northwest Europe (Fig. 1.1). The LEDA Traitbase will be a useful tool in planning, in nature conservation and restoration, and in applied research and will focus on plant traits that describe three key features of plant dynamics: persistence, regeneration and dispersability.
The database was built using several sources of knowledge, including the collation of existing databases, extensive literature compilations, unpublished data from the participants and other colleagues, and additional measurements.

The first challenge of the LEDA Traitbase is to predict plant biodiversity in a changing landscape. For this we need to know if plants can persist and regenerate in their existing habitats and/or can colonise new habitats. The second challenge is to pool transnational expertise on the functional significance of traits, their classification and measurement, while avoiding unnecessary duplication of national initiatives. Knowledge of plant traits is currently growing fast, but remains scattered over many sources, i.e. in dozens of different journals, large monographs, herbarium records. The sources are in several different languages, many even date back to the 19th century. The data are distributed across all different European countries, collected and stored in different ways and mutually not integrated. To date, there has been considerable effort to build up databases to synthesise information on plant traits, but these databases are restricted either to a small species pool or

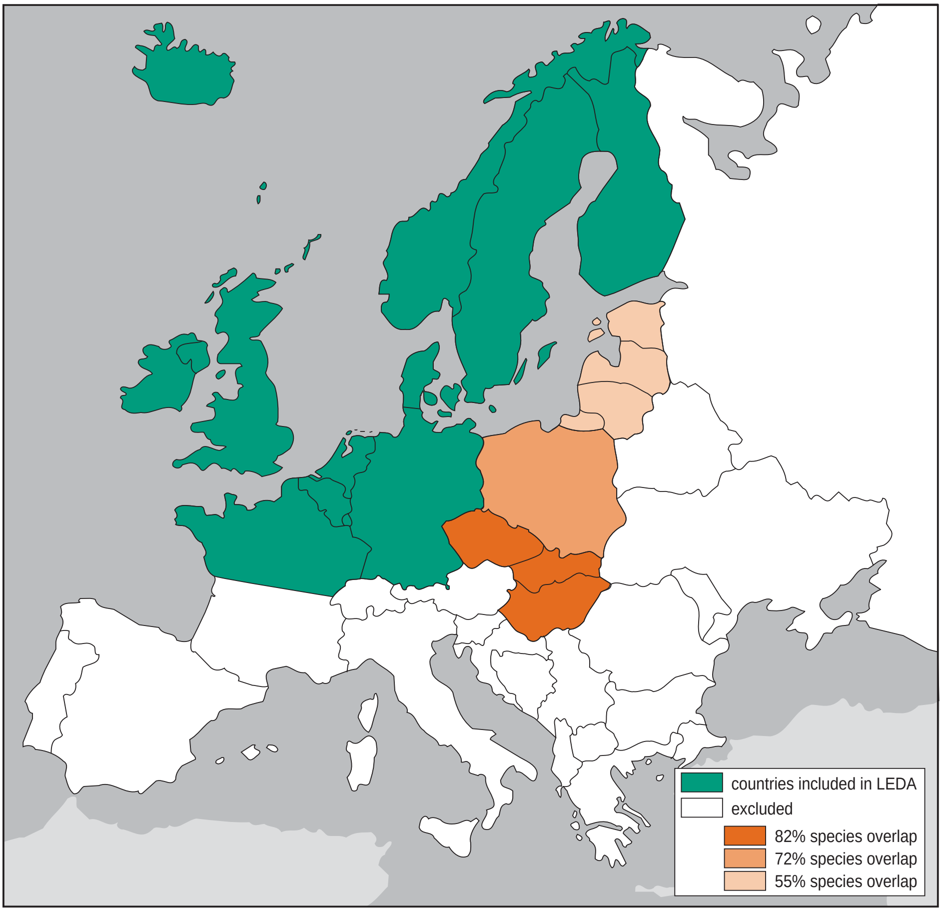

Figure 1.1. *The map shows which Northwest European countries are included in the LEDA Traitbase. The surrounding countries are excluded, but have often a high species overlap with the species incorporated in the LEDA Traitbase (e.g. Poland 72%).*

to only one or two traits. The third challenge is to facilitate retrieval. Researchers or land use managers and planners concerned with large species pools are discouraged from attempting to retrieve and use the scattered information. This severely impedes the functional analysis of plant species-environment relations and the prediction of plant biodiversity change in EU landscapes and regions.

To predict plant biodiversity in a changing landscape, information on whether plants can persist and regenerate in their existing habitats and/or can colonise new habitats is needed. Both abilities depend on their biological traits, i.e. vegetative expansion and multiplication, reproduction, seed bank longevity, and dispersability. On theoretical grounds it can be expected that such life-history traits will form distinct functional combinations. An important challenge for the use of traits to assess biodiversity is to explicitly link function

Table 1.1. *The traits covered by the LEDA Traitbase with their functional ecology and literature reference.*

The LEDA traits	Functional ecology	Reference
Persistence traits		
Canopy height	Competitive ability	(Gaudet & Keddy 1988, Tilman 1988, Goldberg 1996)
Leaf size, leaf distribution along the stem, shoot growth form, plant growth form	Competitive ability	(Rauh 1939, Barkman 1979, Küppers 1989)
Specific Leaf Area (leaf area per unit leaf mass)	Growth rate, competitive ability	(Garnier *et al*. 1997, Wright & Westoby 1999)
Tissue density (leaf dry matter content)	Growth rate, leaf life span	(Ryser 1996, Wilson *et al*. 1999)
Clonal traits (bud bank vertical distribution & seasonality, clonal growth organ, shoot lifespan, persistence parent-offspring connection, no. offspring shoots/parent shoot/year, lateral spread/year)	Competitive ability, persistence, clonal integration, storage, response to disturbance	(De Kroon & van Groenendael 1997, Bellingham & Sparrow 2000, Klimeš & Klimešová 2000)
Regeneration traits		
Plant life span, age of first flowering	Response to disturbance, establishment, invasiveness	(Hodgson 1986, Rejmánek & Richardson 1996)
Seed number/ramet (frequency & period)	Response to disturbance, establishment, dispersal	(Westoby *et al*. 1997, Jakobsson & Eriksson 2000)
Seed weight, size and shape	Dispersal, establishment, seed bank longevity	(Bekker *et al*. 1998, Thompson *et al*. 1998, Kidson & Westoby 2000, Jackel & Poschlod 2000)
Seed bank longevity	Generative regeneration, response to disturbance, restoration	(Bekker *et al*. 1998, Stöcklin & Fischer 1999)
Dispersability traits		
Morphology of dispersal unit	Wind dispersal, ecto- and endozoochorous dispersal	(Özer 1979, Van der Pijl 1982, McCartney 1990, Kiviniemi & Eriksson 1999)
Seed releasing height	Wind dispersal, ecto- and endozoochorous dispersal	(Tackenberg *et al*. 2003)
	Wind dispersal	(Greene & Johnson 1990, Jongejans & Schippers 1999)
External and internal animal dispersal (attachment capacity of the dispersal unit, digestion survival)	Ecto- and endozoochorous dispersal	(Gardener *et al*. 1993, Fischer *et al*. 1996; Kiviniemi 1996)
Buoyancy	(Running) water dispersal	(Danvind & Nilsson 1997; Bill *et al*. 1999)

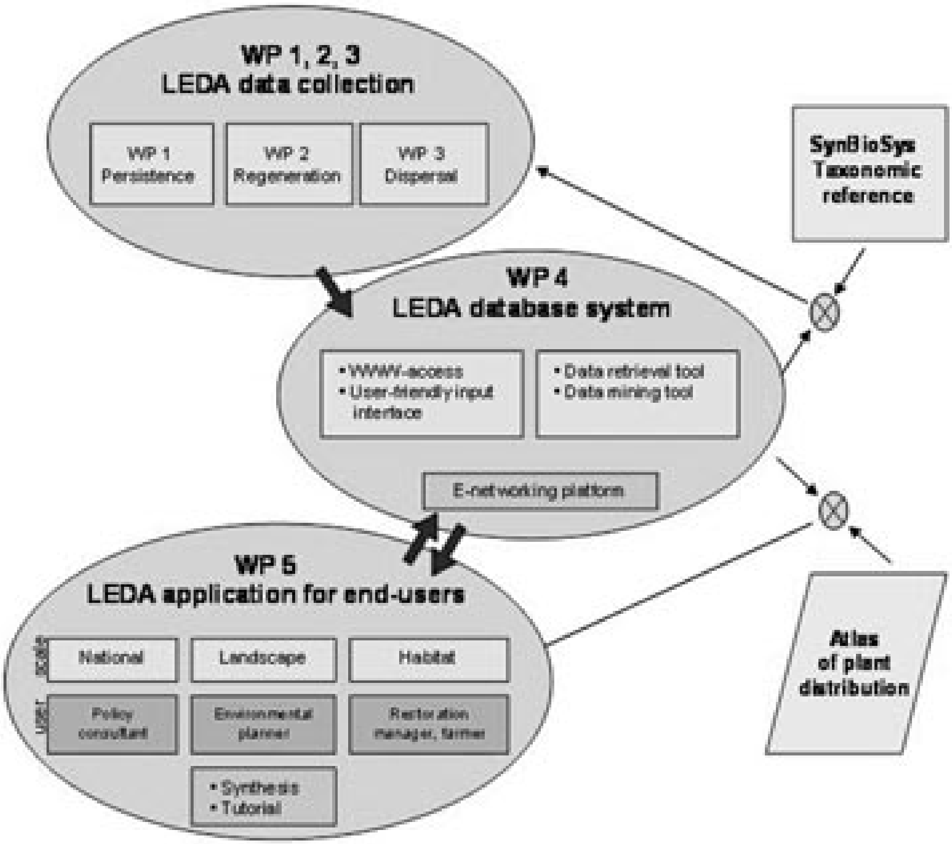

Figure 1.2. *LEDA Traitbase workpackage flow diagram.*

with response to environmental change. Hence, a detailed understanding of the effects of individual traits on functions such as persistence, regeneration and dispersability is necessary (Ehrlén & Van Groenendael 1998) (see Table 1.1). Unfortunately, traits that relate to central functions of plant life such as demography (detailed life history tables, e.g. Meyer & Schmid 1999) or photosynthesis (e.g. carbon balance; Diemer & Körner 1996) are hard to quantify for a large number of species. Given the goal to establish a larger species – trait matrix, these 'hard' traits with demonstrated links to plant functioning can be replaced by more easily measured 'soft' traits (Diaz *et al*. 1999), where function is inferred from correlations to the 'hard' traits. For instance, specific leaf area as an easily measurable trait is positively correlated to relative growth rate (Garnier *et al*. 1997, Wright & Westoby 1999) and may serve as a surrogate for this 'hard' trait. In order to fill the complete species-trait matrix for the Northwest European flora, the LEDA Traitbase will largely compile such 'soft' traits and document their predictive use in a re-analysis of existing case studies, presented on the website.

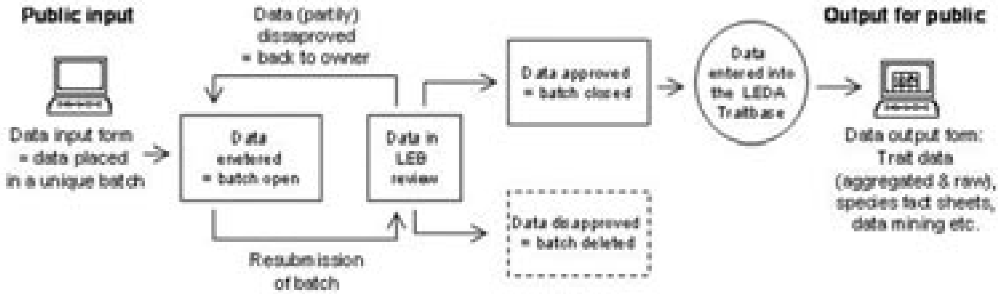

Figure 1.3. *Reviewing process of trait data offered to the LEDA Traitbase.*

LEDA Organisation and Communication

The LEDA Traitbase consortium consists of 10 partners, all from different universities and institutes located in five European countries. For each of the partners a representative is part of the project co-ordinating committee (PCC). The PCC decides high level management issues and maintain contact to potential end-users of LEDA during the course of the project. The PCC is also involved in different issues concerning scientific, technical, exploitation, financial, planning, and control matters.

The LEDA Traitbase project is among the partners divided into five different workpackages (WP) which are concerned with; the collection of data and the assemblage of the species-trait matrix for persistence, regeneration and dispersability traits (WP1-3), building the WWW-based database system together with e-networking user interfaces (WP 4), aggregation techniques and with the applicability of the LEDA Traitbase demonstrated using case studies (WP 5) (Fig. 1.2). The LEDA Traitbase operating system is a user-friendly interface to the WWW-based LEDA Traitbase including an intelligent data mining technique to establish trade-off structures in trait combinations on which to base functional types, and advanced data retrieval techniques to aggregate extracted data. E-networking is established to encourage the user community to continuously update and add to the database during (and after) the project.

Data control: The LEDA Editorial Board (LEB)

An Editorial Board will control and guarantee the scientific standards of data collection, and will check data reliability, and will take the function of a steering committee. The LEB will consist of the partners and external scientists that have expertise in certain traits and are known for their interest in trait databases. Two members from Mediterranean countries were selected to ensure the future enlargement of the database towards the Mediterranean flora.

To enable researchers all over Europe to enlarge the LEDA Traitbase in the future, data can be entered to the Traitbase using the e-networking platform. The e-networking platform included a public data input interface, routines to distribute the input data to members of the LEB in order to check data reliability and consistency, and routines to incorporate checked data into the database system.

When a contributor enters data into the LEDA Traitbase this data will be placed in a unique batch that can only be edited by the data owner (batch owner). The batch will be uploaded and send to the LEDA Editorial Board (LEB) for a data check. After approval of the data, the batch will be closed and entered to the Traitbase (Fig. 1.3). When the data in a batch is disapproved, the batch will be deleted. However if only part of the batch is not accepted, the batch owner will get this part of the batch back for editorial purposes according to LEB instructions. After revision the batch can be resubmitted for approval by the LEB (Fig. 1.3). The batch owner will be notified each time a decision has been made on the batch.

2. THE TRAITBASE ROAD MAP

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The LEDA Traitbase collecting and measuring standards are divided into sections concerning the general standards (Section 2), trait specific standards (Section 3) and reference information and appendices (Section 4). Each section is colour coded to make it easier to find your way through the LEDA collecting and measuring standards.

For trait data entered into the LEDA Traitbase there are some rules that need to be followed to ensure that the data will be accepted:

- LEDA prefers records from literature with known origin source for e.g. a published paper (= original reference).
- For any trait data entered into the LEDA Traitbase it is required to record ALL obligate fields.
- For the <u>general standards</u> information on the data reference (literature, database), geographical references (study area, area code), and description of the sample site (habitat type, sample area size, soil substrate, method of measurement) is required.
- For each of the <u>trait standards</u> the required obligate information that is stated for each trait needs to be provided.
- Trait data obtained from greenhouse or garden experiments are only accepted when all obligate fields can be completed.
- LEDA preferred records from literature with known origin source for e.g. a published paper (= original reference).
- For trait data that are obtained from literature the original data source (original reference) should be filled in separately for each trait when the data is originating from a review paper (i.e. data used in one paper that is originating from another source).

To secure the data quality in the LEDA Traitbase, the criteria for <u>refusing data</u> for the LEDA Traitbase are: The lacking of any obligate information required for the general and/or trait standard, as well as missing information on the number of replicates and the standard deviation or standard error of the mean values of the concerning trait value(s).